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# (54) Exhaust gas re-circulation device for an internal combustion engine

(57) An exhaust gas re-circulation device for an internal combustion engine comprises an intake air channel (10), an intake air control valve (24), an exhaust gas re-circulation valve (20) and an actuator (28). A first motion transmission mechanism is connected between the actuator (28) and the exhaust gas re-circulation valve (20). A second motion transmission mechanism connected between the actuator (28) and the intake air control valve (24). A sense of motion reversing mechanism is included in the first motion transmission mechanism, for reversing the sense of motion of the exhaust gas re-circulation valve (20). The actuator (28) enables, on the one hand, to control exhaust gas re-circulation rates, by simultaneously driving the two valves (20, 24) in opposite senses, and, on the other hand, to obtain a smooth engine shutoff, by simultaneously closing the two valves (20, 24).

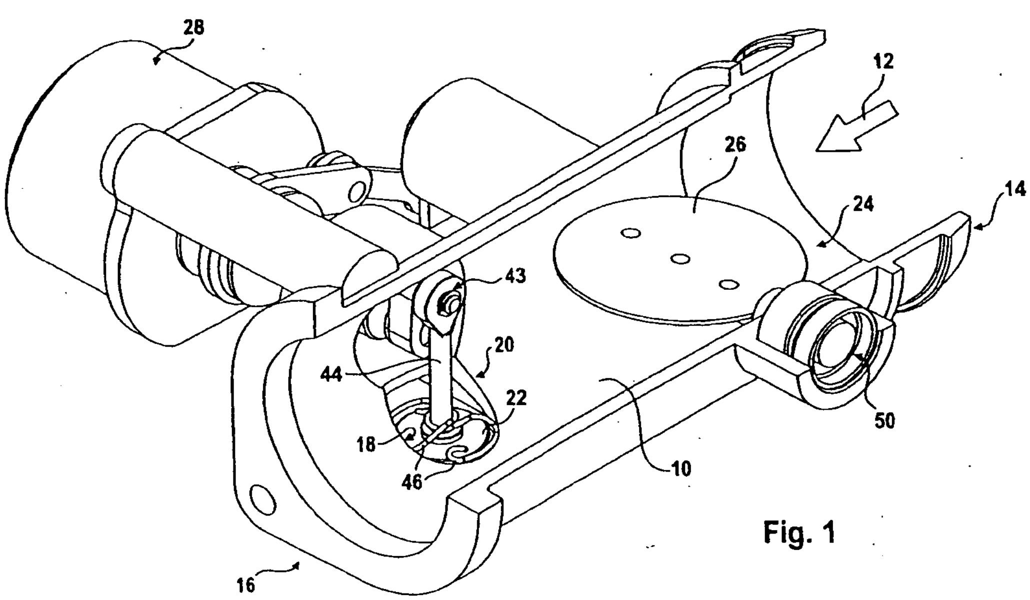


Fig. 1

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## Description

### *Field of the invention*

**[0001]** The present invention relates to an exhaust gas re-circulation device for an internal combustion engine.

### *Background of the invention*

**[0002]** In order to reduce NOx emission of internal combustion engines, it is known to re-circulate oxygen depleted exhaust gases from the engine exhaust in the engine intake air. A device for exhaust gas re-circulation generally includes an intake air tube, an intake air control valve and an exhaust gas re-circulation valve. The intake air control valve allows to throttle the intake air flow in the intake air tube. The exhaust gas re-circulation valve meters the flow of exhaust gases re-circulated into the intake air tube.

**[0003]** Stringent exhaust emission requirements make it necessary to carefully control the proportion of re-circulated exhaust gas into the intake air. Thus, the proportion of re-circulated exhaust gas must at all load levels be sufficient to respect NOx emission limits. However, if the proportion of re-circulated exhaust gas becomes too high, the engine may-due to a lack of oxygen-stop at low load levels or cause undesirable emissions at high load levels. Therefore, it will be appreciated that there is a need for an efficient control of the exhaust gas re-circulation device at all load levels.

**[0004]** It is known to equip the exhaust gas re-circulation valve and the intake air control valve with rotational electric actuators or with linear actuators, such as pneumatic actuators or solenoids, controlled by an engine control module. In such a device low/medium exhaust gas re-circulation rates are controlled by commanding the actuator of the exhaust gas re-circulation valve only; whereas higher exhaust gas re-circulation rates are controlled by commanding the actuator of the exhaust gas re-circulation valve and the actuator of the intake air control valve simultaneously. Fully closing the intake air control valve and exhaust gas re-circulation valve further enables to achieve a smooth engine shut-off. Thus, an efficient control of exhaust gas re-circulation should be possible at all load levels. In practice however, such an exhaust gas re-circulation device still has serious deficiencies. For example, as both valves, i.e. the exhaust gas re-circulation valve and the intake air control valve, influence the intake air flow, it has to be detected which valve is responsible for a measured deviation of a control parameter. Furthermore, the actuators of the two valves are generally of different types, having inter alia different hysteresis errors, which can result in accuracy problems if both valves are to be operated synchronously. Some of these deficiencies can at least partially be compensated by more complex control systems, using for example two sensors, i.e. one for the intake air and one for the re-circulated exhaust gases. However, the more complex the control system is, the more expensive it becomes.

**[0005]** It will be further appreciated that component costs, size and weight are important considerations in automotive vehicle applications. An exhaust gas re-circulation device that is more compact in size can be of advantage, because of limitations on available space in a vehicle engine compartment. Weight reductions of components help of course to reduce fuel consumption of the vehicle. Thus it would be desirable to produce more compact and cost-effective exhaust gas re-circulation devices.

**[0006]** In EP 0900930 is disclosed a compact and cost-effective exhaust gas re-circulation device with an exhaust gas re-circulation valve and a flap valve or strangler that fulfils the function of an intake air control valve. This device comprises one single actuator, which is connected to the actuation shaft of the exhaust gas re-circulation valve. An eccentric on the action shaft drives (i.e. closes) the intake air control valve when the exhaust gas re-circulation valve overruns a certain opening position. This mechanism allows to control with one single actuator low/medium exhaust gas re-circulation rates by driving the exhaust gas re-circulation valve only, the intake air control valve being fully open, and high rate exhaust gas re-circulation rates by driving both the exhaust gas re-circulation valve and the intake air control valve synchronously (the intake air control valve closes when the exhaust gas re-circulation-valve further opens). This rather simple and compact device does of course not provide the same flexibility than a device with two separate actuators separately controlled. Thus it is for example not possible to fully close the intake air control valve and exhaust gas re-circulation valve to achieve a smooth engine shut-off.

### *Object of the invention*

**[0007]** The technical problem underlying the present invention is to provide a simple and compact exhaust gas re-circulation device for an internal combustion engine, which allows an efficient but simple control of exhaust gas re-circulation rates and a smooth engine shut-off. This problem is solved by a device as claimed in claim 1.

### *Summary of the invention*

**[0008]** An exhaust gas re-circulation device in accordance with the invention comprises an intake air channel, an intake air control valve, which is associated with the intake air channel, an exhaust gas re-circulation valve, for re-circulating a controlled amount of engine exhaust gases into the intake air channel, and an actuator. A first motion transmission mechanism is connected between the actuator and the exhaust gas re-circulation valve. A second motion transmission mechanism is connected

between the same actuator and the intake air control valve. In accordance with an important aspect of the present invention, a sense of motion reversing mechanism is included in the first, respectively the second, motion transmission mechanism, for reversing the sense of motion of the exhaust gas re-circulation valve, respectively the intake air control valve. It will be appreciated that this sense of motion reversing mechanism, which is associated either with the first or the second motion transmission mechanism, enables to use one single actuator, (1) for simultaneously driving the two valves in opposite senses (for example by opening the exhaust gas re-circulation valve and simultaneously closing the intake air control valve to increase exhaust gas re-circulation rates, or closing the exhaust gas re-circulation valve and simultaneously opening the intake air control valve to decrease exhaust gas re-circulation rates) and (2) for simultaneously closing the two valves (for example for obtaining a smooth engine shut-off).

**[0009]** The sense of motion reversing mechanism preferably comprises a cam mechanism with a rotational cam with a first and a second guiding slot and at least one follower associated with the two guiding slots. The first guiding slot co-operates with such a follower to open the respective valve when the cam is rotated in a first sense, and the second guiding slot co-operates with a follower to close this valve when the cam is rotated in the same first sense. It will be appreciated that such a cam mechanism allows to easily yield different displacement vs. time functions for both movements.

**[0010]** Such a sense of motion reversing mechanism is preferably included in the first motion transmission mechanism, which includes an auxiliary shaft with a first and a second crank arm. The first crank arm supports the follower(s), and the second crank arm is connected to an actuating stem of the exhaust gas re-circulation valve by means of an articulation.

**[0011]** In order to be able to control for example low exhaust gas re-circulation rates exclusively with the exhaust gas re-circulation valve, wherein the intake air control valve remains for example completely open, coupling means are preferably included in the second motion transmission mechanism for uncoupling the intake air control valve from the common actuator. A preferred embodiment of this coupling means includes a shaft rotated by the actuator; a coupling crank arm, which is freely rotating about the shaft, and a pick-up point, which is fixed to the shaft so that it engages the coupling crank arm at a given angular position of the shaft. In this embodiment the intake air control valve may for example include a flap pivotably mounted in the intake air channel and an actuating lever associated with the flap for pivoting the latter between a closed and an open position. A simple connecting rod may then be used for connecting the actuating lever to the coupling crank arm.

**[0012]** The common actuator is advantageously an electrical torque motor. Such a motor has a small packaging size for a high output torque and is rather insensitive to orientation. It is capable of producing a constant torque over a wide angular range, wherein this output torque can be increased by simply increasing the current.

***Brief description of the drawings***

**[0013]** The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1: is a three-dimensional view of an exhaust gas re-circulation device in accordance with the present invention, wherein an intake air tube is shown partially cut;

Fig. 2: is a three-dimensional view of the exhaust gas re-circulation device of Fig. 1, wherein the intake air tube is not shown at all;

Fig. 3: is a three-dimensional view of the exhaust gas re-circulation device of Fig. 1, showing in detail a mechanism for actuating an intake air control valve; and

Fig. 4: is diagram illustrating in five different stages A, B, C, D, E the operation of the exhaust gas re-circulation device of Fig. 1, each stage being illustrated by a top view, a front view and a three-dimensional view of the exhaust gas re-circulation device, wherein the intake air tube is not shown.

***Detailed description of a preferred embodiment***

**[0014]** In Fig.1 reference number 10 globally identifies a portion of an intake air tube of an internal combustion engine (not shown). The direction of air flow is shown by arrow 12. The upstream-end 14 of the tube 10 is connected, for example via an air cleaner (not shown), to the atmosphere or, in case of an engine with a turbocharger, to a compressor (not shown). The downstream-end 16 of the tube 10 is connected to an intake air manifold of the engine (not shown).

**[0015]** Via an intermediate opening 18, the intake air tube 10 communicates with an exhaust gas duct (not shown) of the engine. Associated with this opening 18 is an exhaust gas re-circulation valve 20, which allows to meter exhaust gas flow through the opening 18. In Fig. 1 the exhaust gas re-circulation valve 20 is shown in a closed position, wherein an obturating disc 22 sits on a valve seat and is gastightly sealing the opening 18.

**[0016]** Upstream of the opening 18 is arranged a flap valve, the so called intake air control valve 24, which allows to meter intake air flow. In Fig. 1 the intake air control valve 24 is shown in an entirely open position, wherein a flap 26 is substantially parallel to the central

axis of the intake air tube 10, thus offering a minimum resistance to air flow. This flap 26 is designed to provide, in the closed position of the intake air control valve 24, a substantially airtight sealing of the inlet section of the tube 10.

**[0017]** Referring now simultaneously to Fig. 1, Fig. 2 and Fig. 3, the actuation mechanism of the exhaust gas re-circulation valve 20 and the intake air control valve 24 will be described in detail. This actuation mechanism comprises one single actuator 28, which is advantageously an electric rotary motor, as for example a torque motor. If a linear motor is preferred as actuator, it will for example be possible to use a solenoid or a pneumatic actuator. A beam-and-crank mechanism or a rack-and-pinion gear may then be used for transforming the linear movement of the actuator into a rotational movement.

**[0018]** The actuator 28 drives a main shaft 30 supporting a cam 32 at its free end. This cam 32 includes two substantially symmetric guiding slots 34 and 36 for a follower 34', respectively a follower 36'. The followers 34' and 36' are supported by a first rigid crank arm 38 of an auxiliary shaft 40, which penetrates into the tube 10 through a gastight bearing (not shown). Inside of the tube 10, the auxiliary shaft 40 supports a second rigid crank arm 42. The latter is connected by means of an articulation 43 to a actuating stem 44, which supports the obturating disk 22 of the exhaust gas re-circulation valve 20. As shown on Fig. 1, the actuating stem 44 is centred in the opening 18 by a valve guide 46.

**[0019]** Concerning the intake air control valve 24, it will be noted that the flap 26 is mounted on a shaft 48 which is supported by two bearings 50, 52 at two diametrically opposed locations of the tube 10 (see Fig. 1 & 2). Outside of the tube 10, the shaft 48 has a rigid lever 54 (see Fig. 3). The latter is connected by means of an articulated connecting rod 56 to a crank arm 58 that is freely rotating about the main shaft 30. A pick-up point 60 is fixed to the main shaft 30. At a certain angular position of the main shaft 30, this pick-up point 60 engages a follower 62 of the crank arm 58, so that the main shaft 30 drives the crank arm 58, thereby rotating the shaft 48, via the connecting rod 56 and the lever 54.

**[0020]** Referring now to Fig. 4, the operation of the above described actuation mechanism will be analysed in detail. It will be noted that the diagram of Fig. 4 shows five consecutive operation stages A, B, C, D, E of the exhaust gas re-circulation device described above with reference to Fig. 1 to 3. Each stage is illustrated by a top view, a front view and a three-dimensional view of the device. The intake air tube 10 is not shown.

**[0021]** In stage A the exhaust gas re-circulation device is in its zero position. The exhaust gas re-circulation valve 20 is entirely closed, i.e. the obturating disk 22 sits on its seat and closes the opening 18 gastightly. The intake air control valve 24 is entirely open, i.e. the flap 26 is substantially parallel to the central axis of the intake air tube 10, thus offering a minimum resistance to air flow. As best seen in the front view, the pick-up point 60 of the main shaft 30 is still spaced from the follower 62 of the crank arm 58, so that a rotation of the main shaft 30 does not yet affect the position of the intake air control valve 24. The intake air control valve 24 is advantageously kept in this fully open position by a spring (not shown). The latter produces an elastic force urging the motion transmission mechanism 58, 56, 54 of the intake air control valve 24, which is still uncoupled from the actuator, in the direction of arrow 65 against a stop (not shown).

**[0022]** If, starting from stage A, the main shaft 30 is rotated by the actuator 28 in the sense of arrow 64, the follower 34' follows the profile of guiding slot 34, whereby the crank arms 38 and 42 are rotated in the same sense as the main shaft 30. During this rotation the crank arm 42 pushes the actuating stem 44, which is guided by the valve guide 46 in the opening 18, obliquely downwards, thus pushing the obturating disk 22 from its seat.

**[0023]** It will be noted that as long as the rotation amplitude of main shaft 30 does not exceed the angle X, the pick-up point 60 of the main shaft 30 does not engage the follower 62 of the crank arm 58, and the intake air control valve 24 will therefore remain in its fully open position. Hence, by moving the main shaft 30 between angular positions X0 and X1, low/medium exhaust gas re-circulation rates can be efficiently controlled by exclusively driving the exhaust gas re-circulation valve with actuator 28, the intake air control valve 24 remaining in its fully open position. In other words, exhaust gas re-circulation is exclusively controlled by metering the flow of exhaust gases through the opening 18.

**[0024]** In stage B the exhaust gas re-circulation device is shown in a transition position between the control range of low/medium exhaust gas re-circulation rates and the control range of high exhaust gas re-circulation rates. The exhaust gas re-circulation valve 20 is already open, i.e. the obturating disk 22 is lifted from its seat and exhaust gases can flow into the intake air tube 10. The intake air control valve 24 is still entirely open, i.e. the flap 26 is substantially parallel to the central axis of the intake air tube 10, thus offering a minimum resistance to air flow. As best seen in the front view, the pick-up point 60 of the main shaft 30 is close to engaging the follower 62 of the crank arm 58.

**[0025]** If, starting from this stage B, the main shaft 30 is further rotated by the actuator 28 in the sense of arrow 64, the follower 34' continues to follow the profile of guiding slot 34, whereby the crank arms 38 and 42 are further rotated in the same sense as the main shaft 30. This pushes the obturating disk 22 further from its seat, thereby reducing pressure losses in the opening 18.

**[0026]** As the pick-up point 60 of the main shaft 30 engages the follower 62 of i the crank arm 58, the crank arm 58 is now also rotated in the same sense as the main shaft 30. Via the connecting rod 56 and the lever 54, the shaft 48 with the flap 26 is rotated in the sense of arrow 66. It follows that the intake air control valve 24

is closing, while the exhaust gas re-circulation valve 20 is simultaneously further opening. Thus, by moving the main shaft 30 over angular position X1 high exhaust gas re-circulation rates can be efficiently controlled by simultaneously driving the exhaust gas re-circulation valve 20 and the intake air control valve 24 with actuator 28 in opposite senses (i.e. opening the exhaust gas re-circulation valve 20 and simultaneously closing the intake air control valve 24 to increase exhaust gas re-circulation rates, or closing the exhaust gas re-circulation valve 20 and simultaneously opening the intake air control valve 24 to decrease exhaust gas re-circulation rates). It will be appreciated that the spring biasing the intake air control valve 24 in the fully open position now warrants that the follower 62 of the crank arm 58 closely follows the pick-up point 60 of the main shaft 30.

**[0027]** In stage C the follower 34' enters a mouth region of guiding slot 34. In this mouth region the cam 32 is no longer capable of communicating motion to the follower 34'. The position of the exhaust gas re-circulation valve 20 remains consequently unchanged when the main shaft 30 is further rotated by the actuator 28 in the sense of arrow 64. However, the shaft 48 of the intake air control valve 24 continuous to be rotated in the sense of arrow 66. In other words, if starting from stage C, the main shaft 30 is rotated by the actuator 28 in the sense of arrow 64, then the intake air control valve 24 is further closing, while the exhaust gas re-circulation valve 20 remains in its fully open position.

**[0028]** In stage D the exhaust gas re-circulation device is in a transition position between the control range of high exhaust gas re-circulation rates and smooth engine shut-off. The follower 34' has left the guiding slot 34, and the follower 36' has already engaged the guiding slot 36. If the main shaft 30 is further rotated by the actuator 28 in the sense of arrow 64, the follower 36' follows the profile of guiding slot 36, whereby the crank arms 38 and 42 are now rotated in the opposite sense of the main shaft 30. This rotation of crank arm 42 pulls the actuating stem 44 in the direction of arrow 68, thus reducing more and more the flow of exhaust gases through the opening 18. Simultaneously, the shaft 48 of the intake air control valve 24 continues to be rotated in the sense of arrow 66, i.e. the intake air control valve 24 continues to close. In other words, in order to produce a smooth engine shut-off, the sense of motion exhaust gas re-circulation valve 20 is reversed so that the latter and the intake air control valve 24 can be simultaneously closed by a rotation of the shaft in the sense of arrow 64.

**[0029]** In stage E the exhaust gas re-circulation device is shown in its closed end position. The exhaust gas re-circulation valve 20 and the intake air control valve 24 are both fully closed. The engine shut-off mode is achieved.

**[0030]** It may be desirable to design the motion transmission mechanisms so that the exhaust gas re-circulation valve 20 is already completely closed before the intake air control valve 24 completely closes. In this case it is important to uncouple the obturating disc 22, which sits already on its seat, from the main shaft 30, which must continue to rotate in the sense of arrow 66 to fully close the intake air control valve 24. Such an uncoupling can be achieved for example by incorporating an elastically deforming element in the chain of links connecting the obturating disc 22 to the main shaft 30. Possible embodiments of such an elastically deforming element are for example a torsion spring associated with a crank arm 58, wherein the latter must then be capable of rotating about the shaft 40, or an axial spring associated with a telescopic stem 44. Alternatively, the obturating disc 22 or its seat could be designed so as to elastically deform under the traction force exerted on the obturating disc 22. Another solution achieving the same result would be to design the end portion of the slot 36 so that the cam 32 is no longer capable of communicating motion to the follower 36' in this end portion.

**[0031]** The return from the closed end position of stage E to the idle position of stage A can for example be achieved by rotating the actuator main shaft 30 in the opposite sense of arrow 64, thereby passing successively through stages D, C, B to finally arrive at stage A, i.e. the idle position. It will be noted that the spring maintaining the intake air control valve 24 in the fully open position warrants that the follower 62 of the crank arm 58 closely follows the pick-up point 60 of the main shaft 30, while the latter is rotated in the opposite sense of arrow 64, until the intake air control valve 24 is in its completely open position, which is defined by a mechanical stop. It will further be appreciated that rotating the actuator main shaft 30 in the opposite sense of arrow 64 can be achieved either by reverse mode actuation of the actuator 28 during a power latch mode of the engine control unit, or by spring return of the actuator 28 when the current supply of the actuator 28 is cut.

**[0032]** In the embodiment described above, the exhaust gas re-circulation device is provided with a mechanism producing in stage D a reversion of the sense of motion of the exhaust gas re-circulation valve 24. Alternatively, the exhaust gas re-circulation device could also be provided with a mechanism producing in stage D a reversion of the sense of motion of the intake air control valve 24. In this case the sense of motion of the actuator 28 must however be reversed in stage D in order to simultaneously close the exhaust gas re-circulation valve 20 and the intake air control valve 24.

**[0033]** Furthermore, the mechanism producing in stage D a reversion of the sense of motion must not necessarily be a cam mechanism. It could for example also be a beam-and-crank mechanism designed to have a dead point in stage D. However, a crank mechanism provides more facilities for tuning the opening of the exhaust gas re-circulation valve 20. Thus it will for example be appreciated that in the mechanism shown in Fig. 4 the fully closed position of the exhaust gas re-circulation valve 20 in stage A and the fully open position of this valve 20 in stage D are spaced by an angle of about 60°,

whereas the fully open position of this valve 20 in stage D and the fully closed position of this valve 20 in stage E are only spaced by an angle of about 8°. It follows that closing the exhaust gas re-circulation valve 20 for smooth shut off of the engine can be achieved rather quickly, whereas a relatively broad angular range is provided for control purposes of exhaust gas re-circulation.

**[0034]** In the embodiment described above, the pick-up point 60 of the main shaft 30 and the freely rotating crank arm 58 with its follower 62 form a coupling means for uncoupling the intake air control valve 24 from the common actuator 28 for the control of low/medium exhaust gas re-circulation rates between angular position X0 to angular position X1. It will be understood that other types of couplings or clutches could be used to perform the same function, provided that they are capable of uncoupling the intake air control valve 24 from the common actuator at a given position of the actuator shaft. Furthermore, the motion transmission mechanism connected between the actuator 28 and the intake air control valve 24 must not necessarily be a beam-and-crank mechanism. It could for example also be a gear mechanism, a cam mechanism or a belt or chain drive.

**[0035]** In the embodiment described above, the idle position is characterised in that the exhaust gas re-circulation valve is in the fully closed position and the intake air control valve is in the fully open position. This is typical for a Diesel engine. For a gasoline engine however, the idle position will generally be characterised in that the exhaust gas re-circulation valve and the air intake control valve are both in the closed position. In such a gasoline engine the air intake control valve must be opened in advance of the exhaust gas re-circulation valve. Furthermore, a parallel opening or closing of both valves can be used for controlling low re-circulation rates, whereas high re-circulation rates are preferably controlled by simultaneously driving the two valves in opposite senses (for example by opening the exhaust gas re-circulation valve and simultaneously closing the intake air control valve to increase exhaust gas re-circulation rates, or closing the exhaust gas re-circulation valve and simultaneously opening the intake air control valve to decrease exhaust gas re-circulation rates).

## Claims

1. Exhaust gas re-circulation device for an internal combustion engine comprising:

   an intake air channel (10);

   an intake air control valve (24) associated with said intake air channel (10); and

   an exhaust gas re-circulation valve (20) for re-circulating a controlled amount of engine exhaust gases into said intake air channel (10);

   an actuator (28);

   a first motion transmission mechanism connected between said actuator (28) and said exhaust gas re-circulation valve (20);

   a second motion transmission mechanism connected between said actuator (28) and said intake air control valve (24), and

   characterised by

   a sense of motion reversing mechanism included in said first, respectively said second motion transmission mechanism, for reversing the sense of motion of said exhaust gas re-circulation valve (20), respectively said intake air control valve (24).

2. Exhaust gas re-circulation device as claimed in claim 1, characterised in that said sense of motion reversing mechanism is included in said first motion transmission mechanism for reversing the sense of motion of said exhaust gas re-circulation valve (20).

3. Exhaust gas re-circulation device as claimed in claim 1 or 2, characterised in that said first motion transmission mechanism comprises a cam mechanism (32, 34, 36, 34', 36').

4. Exhaust gas re-circulation device as claimed in claim 3, characterised in that said cam mechanism includes a rotational cam (32) with a first guiding slot (34), a second guiding slot (36) and at least one follower (34', 36'), wherein said first guiding slot (34) co-operates with a follower (34') to open said exhaust gas re-circulation valve (20) when the cam (32) is rotated by said actuator (32) in a first sense, and said second guiding slot (36) co-operates with a follower (36') to close the exhaust gas re-circulation valve (20) when the cam is rotated in said first sense.

5. Exhaust gas re-circulation device as claimed in claim 4, characterised in that

   said exhaust gas re-circulation valve (20) includes an actuating stem (44);

   said first motion transmission mechanism includes an auxiliary shaft (40) with a first and a second crank arm (38, 42);

   said first crank arm (38) supports said at least one follower (34', 36'); and

   said second crank arm (42) is connected by means of an articulation (43) to said actuating stem (44).

6. Exhaust gas re-circulation device as claimed in any one of claims 1 to 5, characterised by coupling means included in said second motion transmission mechanism for uncoupling said intake air control valve (24) from said common actuator (28).

7. Exhaust gas re-circulation device as claimed in claim 6, characterised in that said coupling means includes:

   a shaft (30) rotated by said actuator (28);

   a coupling crank arm (58) that is freely rotating about said shaft (30); and

   a pick-up point (60) fixed to said shaft (30) so that it engages said coupling crank arm (58) at a given angular position of said shaft (30).

8. Exhaust gas re-circulation device as claimed in claim 7, characterised in that said intake air control valve (24) includes:

   a flap (26) pivotably mounted in said intake air channel (10); and

   an actuating lever (54) associated with said flap (26) for pivoting the latter between a closed and an open position.

9. Exhaust gas re-circulation device as claimed in claim 8, characterised by a connecting rod (56) connecting said actuating lever (54) to said coupling crank arm (58).

10. Exhaust gas re-circulation device as claimed in any one of claims 1 to 9, characterised in that said actuator (28) is an electrical torque motor.

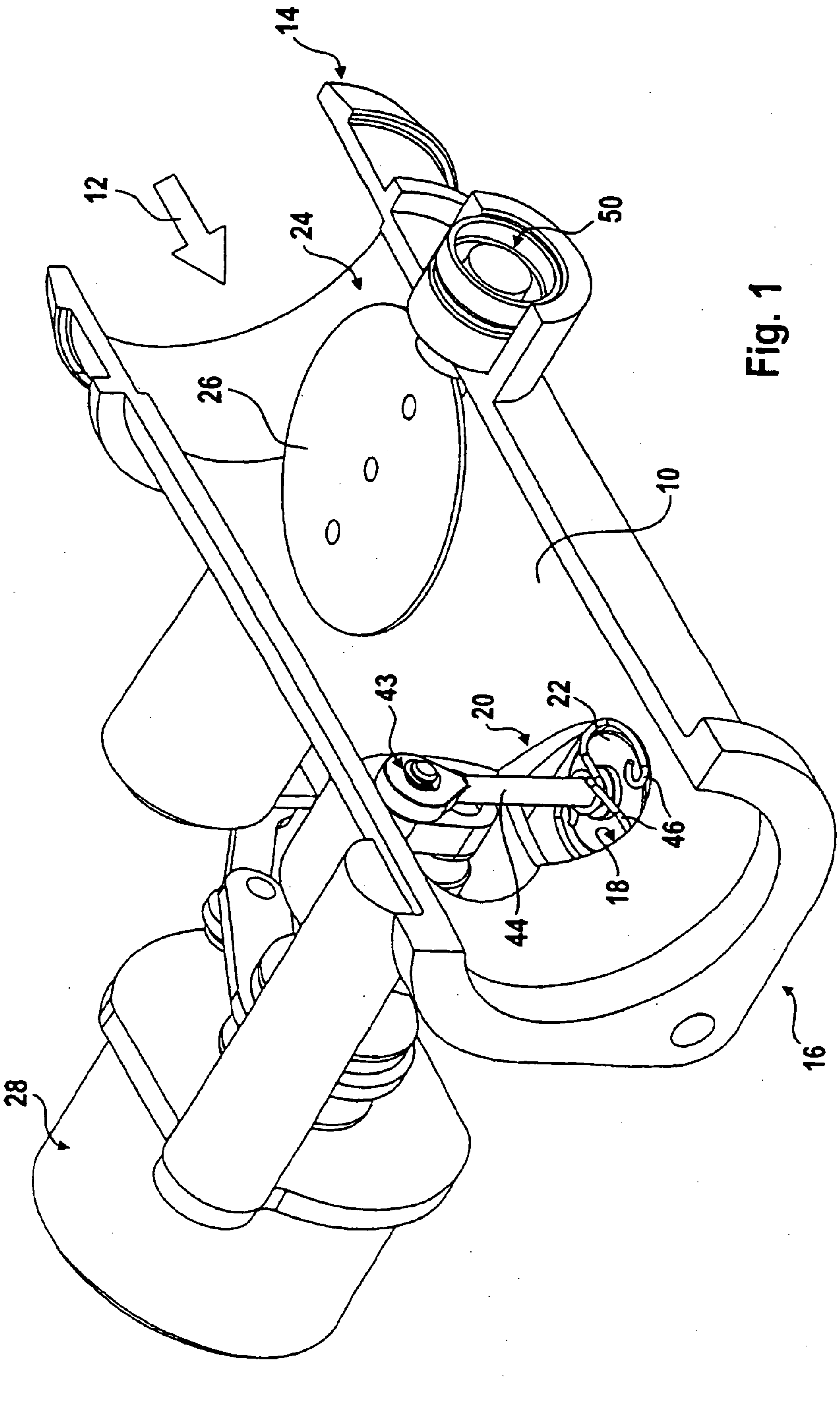



Fig. 1

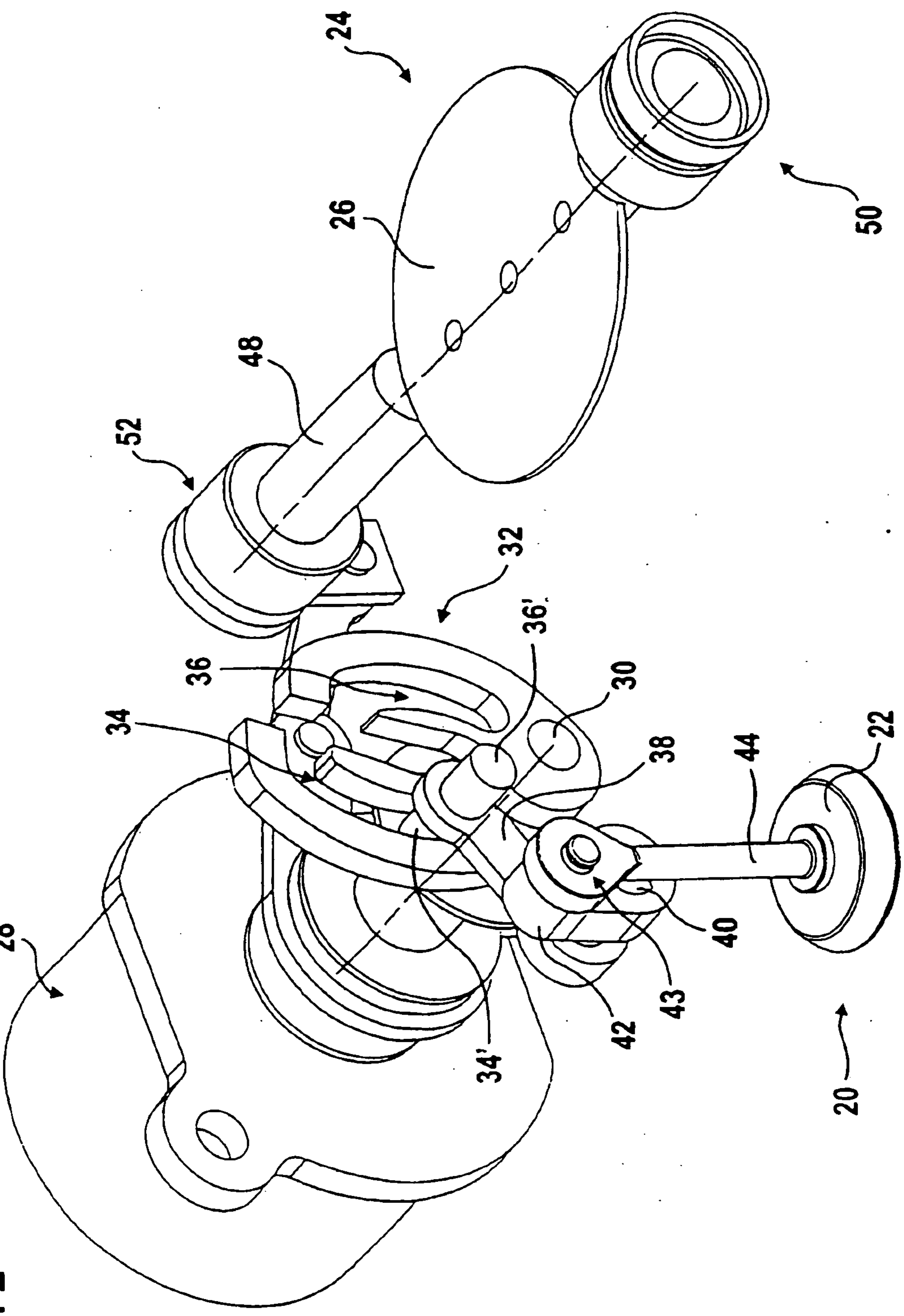
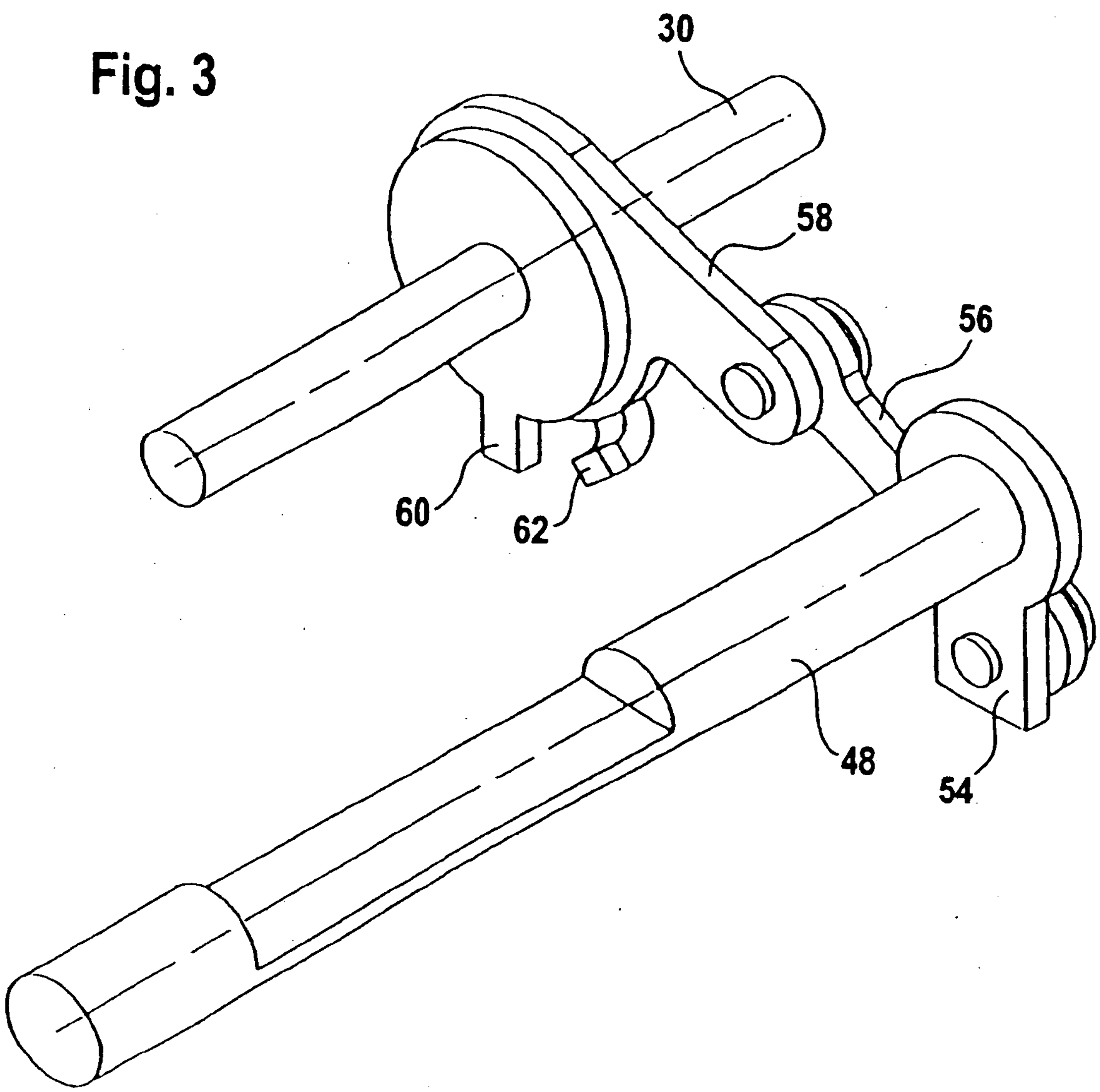



Fig. 2

Fig. 3



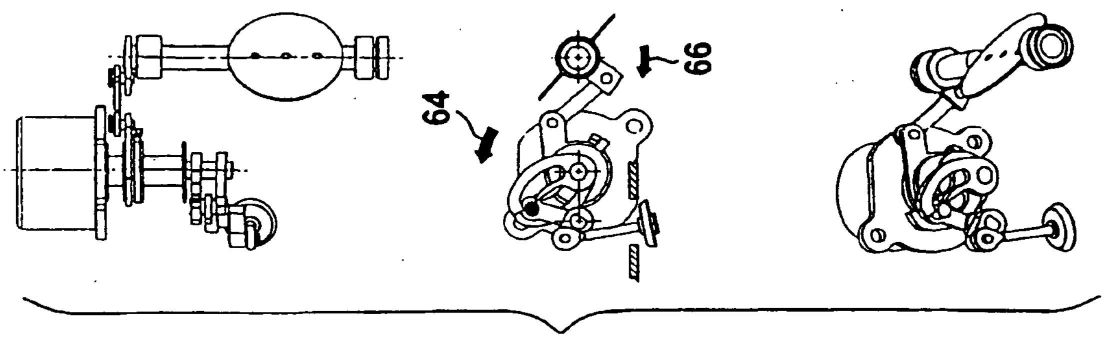



Fig. 4C

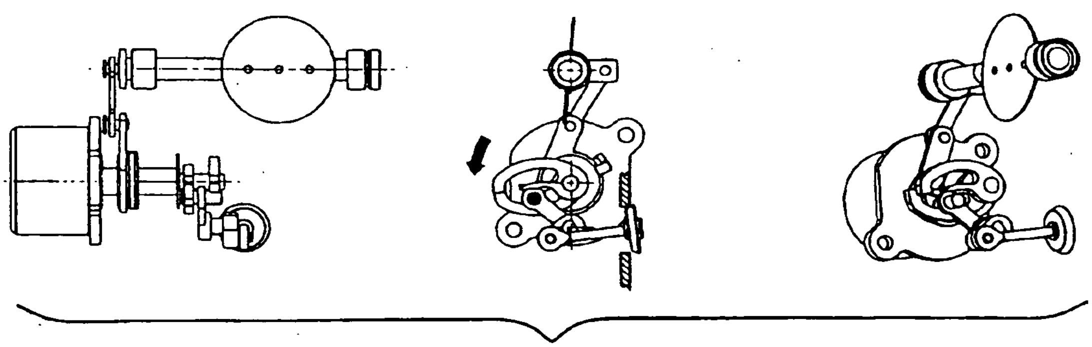


Fig. 4B

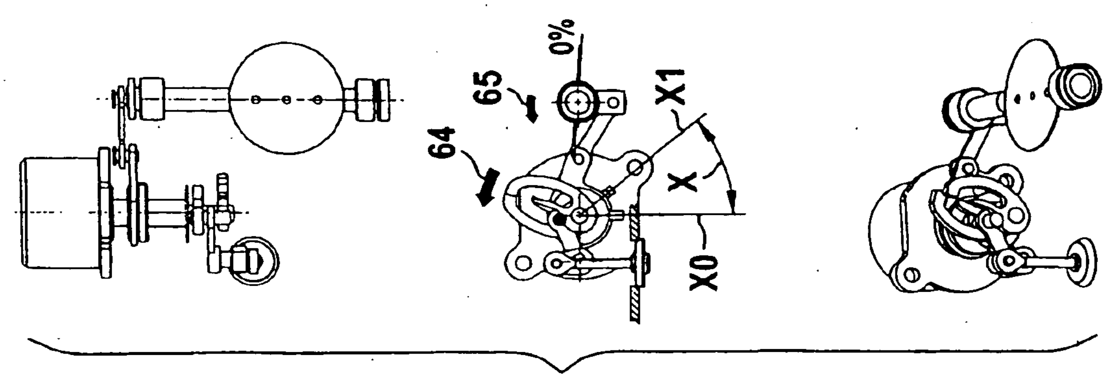



Fig. 4A

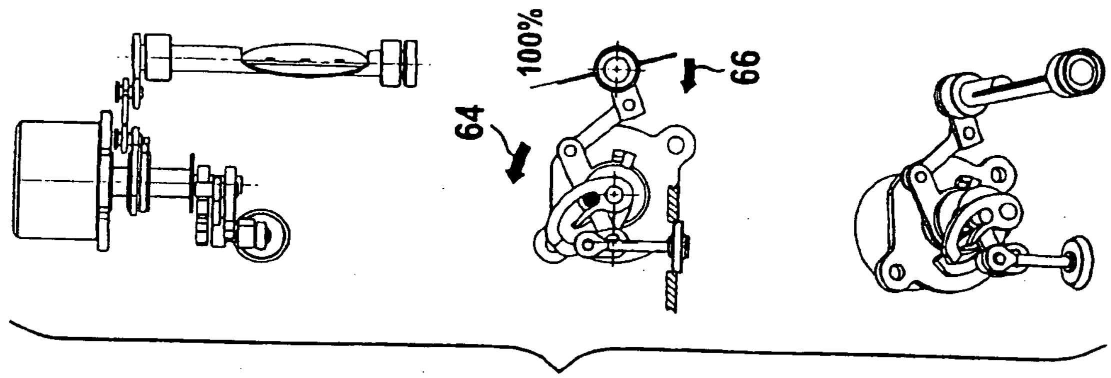



Fig. 4E

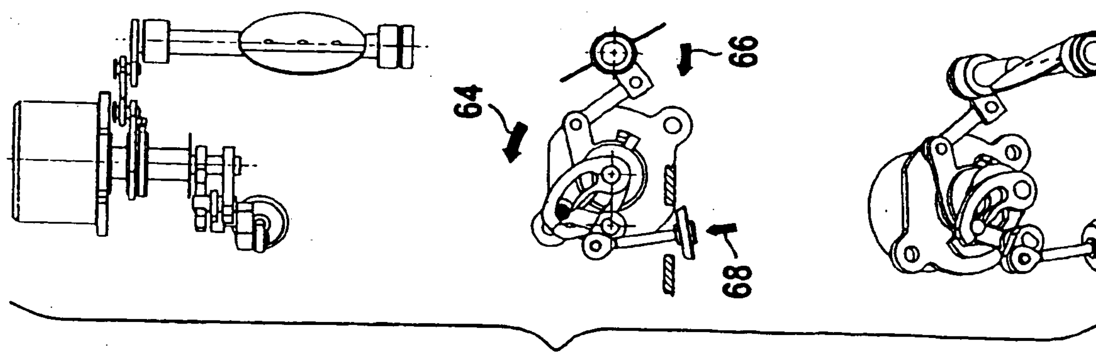



Fig. 4D

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 00 12 6023

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
|---|---|---|---|
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